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# Deploy a 5G network in less than 5 minutes

## Demo Abstract

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## ABSTRACT

We describe a demonstration run on R2lab, an anechoic chamber located at Inria Sophia Antipolis, France. The demonstration consists in deploying a standalone 5G network in less than 5 minutes. All the network components (base station, subscriber management, serving and packet gateways, network traffic analyzers) were run automatically using the nepi-ng experiment orchestration tool. Download and upload performance to the Internet from a commercial phone located in the anechoic chamber are shown.

## 1 INTRODUCTION

Open Air Interface (OAI) [2] is an open-source software-based LTE ecosystem for prototyping 5th Generation Mobile Networks and devices. OAI currently provides a standard-compliant implementation of a subset of Release 10 LTE for UE (User Equipment), eNB (LTE Base station), MME (Mobility Management Entity), HSS (Home Subscriber Server), SGW (Serving Gateway) and PGW (Packet Data Network Gateway) on standard Linux-based computing equipment (Intel x86 PC architectures). It is therefore possible to run advanced experiment scenarios such as Cloud Radio Access Network (C-RAN) with different functional splits, Beamforming or Coordinated Multipoint.

However, several challenges need to be tackled to ease the deployment of such scenarios:

- **Cost and hardware availability:** to build such an experimentation scenario, it is required to dedicate a handful of PCs with the right OS and proper low-latency flavored kernel. A typical deployment will require one box to host an eNB (e-NodeB, or base station), another box to host the HSS (Home Subscriber Service), and a last box to run the MME (Mobility Management Entity) and SGW and PGW (Serving and Packet gateways, respectively).

As far as the base station is concerned, the right kind of ETTUS Universal Software Radio Peripheral (USRP) device is required as well such as a B210 or a X210 board. Furthermore, when using a USRP B210 board, a duplexer band 7 needs to be attached, as the distance between the RX and TX antenna SMA connectors on the USRP B210 board is such that the TX antenna generates too much interferences to the RX channel.

Finally, whether the UE (User Equipment) is implemented on a commercial phone, or as a software component, each option comes with its own set of challenges. The

former option requires a dummy SIM card while the latter requires proper configuration and another B210 board with a duplexer band 7 attached differently than for the one for the base station.

- **Licensed frequency spectrum:** the 2.6GHz band 7 is dedicated to LTE and LTE Advanced operators. So, running an LTE experimentation without authorization license is problematic. On the one hand, production LTE networks will add noise to the experimentation scenario and on the other hand, the experimentation may prevent legitimate LTE users from reaching their network.
- **High complexity to set up the OAI demo:** even if the hardware is available and a license is obtained, there is a long list of operations to perform in order to deploy OAI scenarios<sup>1</sup>.

## 2 DEPLOYMENT IN R2LAB

In this demonstration<sup>2</sup>, we use the FIT R2lab [1] wireless testbed to overcome the above mentioned challenges and provide an experimentation environment with a much lower barrier to entry.

The R2lab testbed is an anechoic chamber located at Inria Sophia Antipolis, offering 37 remotely accessible PCs and equipped with different wireless technologies, for instance Wi-Fi a/b/g/n cards, 5 USRP B210 with duplexer band 7 attached, plus a dozen of USRP2/-N210/USRP1 that could be used for spectrum analysis or noise generator. In addition, R2lab also exposes a commercial Nexus 5 Phone, with OAI SIMcard, and programmable with Android Debug Bridge. In addition, the testbed provides hardware and software support for OAI. Therefore R2lab would allow to control the entire chain in a complex 5G scenario from the C-RAN to the RF front-ends. This addresses the first challenge mentioned above.

R2lab provides a controlled environment, shielded from the outside interferences, and thus allows to test wireless experimental setups that uses licensed bands without the need for any special authorization. This solves the second challenge mentioned above. In addition, easy reservation of the whole testbed is also supported through the R2lab website. This allows avoiding interference from other experiments possibly running in parallel.

We also developed efficient scripts that automate the whole OAI demo set-up in few minutes using nepi-ng<sup>3</sup>. Network Experiment

<sup>1</sup> See the full list of these operations at <https://gitlab.eurecom.fr/oai/openairinterface5g/wikis/HowToConnectCOTSUEwithOAIeNBNew>

<sup>2</sup> See <https://www.youtube.com/watch?v=N1nL.PqWlKw>

<sup>3</sup> See <https://nepi-ng.inria.fr/>

Programming Interface - new generation is a tool for orchestrating network experiments in an automated and efficient way. It is mainly used for alleviating problems related to provisioning the environment and running all the different steps of the wireless scenarios. This allows for a limited human intervention and thus less manipulation errors. We used nepi-ng to write and automate the whole experimentation scenario, including collection of all log files.

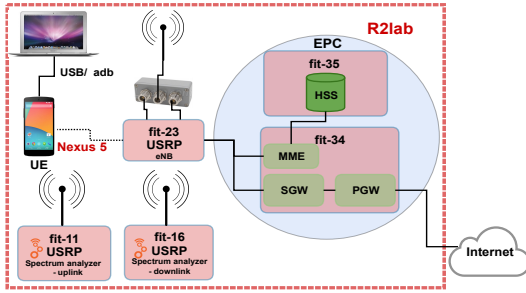


Figure 1: OAI-based 5G network deployed in R2lab

### 3 EXPERIMENT SCENARIO

The experiment scenario consists of creating a standalone 5G network, testing the upload and download speed of a UE, and visualizing the corresponding spectrum in real-time.

As mentioned earlier, the base station and the core network are implemented on Intel x86 machines using OAI; a commercially available unmodified Nexus 5 with an OAI SIMcard is used as a user equipment (UE), see Figure 1. We chose to use a B210 ETTUS USRP with a duplexer band 7 as a radio front-end for the eNB hosted on fit-23 node. We allocate node fit-35 for the (HSS), this node is dedicated to authenticating. On node fit-34, we run other pieces of the LTE infrastructure, namely the MME, as well as the SGW and PGW gateways, that primarily implement external connectivity to UE terminals.

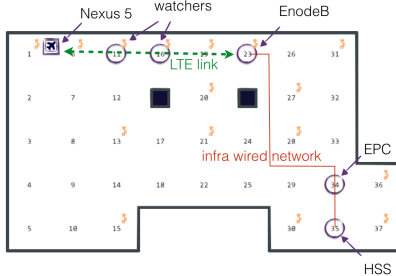


Figure 2: R2lab scenario

All these elements are depicted in Figure 2. Additionally, during the experiment we also dedicate two other USRPs for analyzing the spectrum, called watchers; it is very easy to use such nodes to generate controlled interferences, using respectively `gnuradio's` `uhd_fft` and `siggen`.

As mentioned before, we reserve the whole testbed in our experiments to avoid interference from other users, and we only setup resources dedicated to the experiment to avoid problems of unintended RF activities from idle nodes. We also make sure to provision the infrastructure in the right order: first the HSS; then the MME, the SGW and the PGW; then only the eNodeB; and finally the phone connects to the network. This allows to avoid problems related to synchronization. During this phase, the UE remains in airplane mode until the provisioning is finished.

In order to measure the upload and download speed of the UE through the deployed 5G network, we use the speedtest.net application. Figure 3 provides a screen shot with the speedtest App interface on the right and the output of two traffic analyzers on the left side, showing the activity one for the downlink and the other for the uplink.

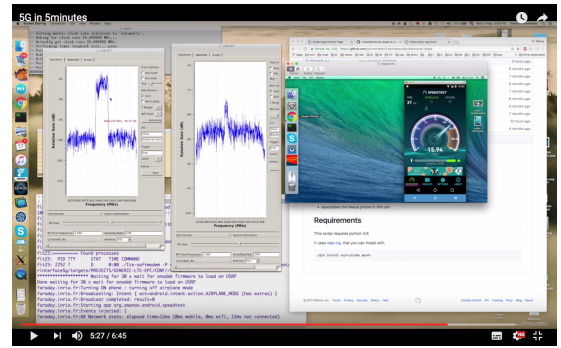


Figure 3: Download performance and traffic analyzer

### 4 CONCLUSIONS

This demonstration shows that advanced realistic 5G scenarios can be easily and rapidly deployed with OAI software support in the R2lab anechoic chamber. Several scenarios can be run in this environment, thus exploiting the full control of end-to-end scenarios.

Debugging OpenAirInterface can be tricky, even for experts. The anechoic R2lab testbed offers a controlled environment that is key in reproducing experiments and debugging. Indeed, using the R2lab utilities, it is straightforward to run the same experimentation scenario with two versions of OAI and compare the performance obtained or analyze logs, e.g., pcap traces to find out and solve possible issues.

### ACKNOWLEDGMENTS

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- [2] NIKAEIN, N., MARINA, M. K., MANICKAM, S., DAWSON, A., KNOPP, R., AND BONNET, C. Openairinterface: A flexible platform for 5g research. *ACM SIGCOMM Computer Communication Review* 44, 5 (2014), 33–38.

**Technical requirements for the demo:**

- Equipment to be used for the demo: None
- Space needed: regular
- Setup time required : 5 minutes
- Additional facilities needed: power and Internet access are needed.